ISSN (print) 0093-4666 © 2015. Mycotaxon, Ltd. ISSN (online) 2154-8889

MYCOTAXON

http://dx.doi.org/10.5248/130.361

Volume 130, pp. 361–367 April–June 2015

Contribution to the knowledge of *Inonotus baumii* in Thailand

Anon Auetragul[1], Oratai Euatrakool[2],
Maria Letizia Gargano[3], & Giuseppe Venturella[3*]

[1] *AnonBiotec Institute, Department of Biotech, The North Chiangmai University,
Talad Thai, Klongsong, Klongluang, Patumthani 12120, Chiangmai, Thailand*
[2] *Office of Agricultural Regulation, Department of Agriculture,
Chatuchak, Bangkok, 10900 (Thailand)*
[3] *Department of Agricultural and Forest Sciences, University of Palermo,
Viale delle Scienze, Bld. 4, I-90128 Palermo (Italy)*
* Correspondence to: *giuseppe.venturella@unipa.it*

Abstract —*Inonotus baumii* in Thailand is reported on three new host-plants: *Acacia tomentosa*, *Shorea robusta*, and *S. siamensis*. A key for the identification of *Inonotus* species in Thailand accompanies notes on the taxonomy of *I. baumii*.

Key words — *Basidiomycota*, *Hymenochaetales*, *Phellinus*, white rot fungus

Introduction

Fungi are one of the most species-rich groups of organisms but compared to plants they are still vastly under-investigated (Hawksworth 1997). In particular there is still a lack of distribution and ecological data on several fungal species (Venturella et al. 2011). This is even more true for wood-inhabiting fungi, which have become increasingly important in recent years not only for their ecological role but also as natural sources of anticancer, antioxidative, and antibacterial agents (Karaman et al. 2010).

Several wood-decaying species are used in Asian folk medicine (Larsson et al. 2006). An example is *Inonotus baumii*, sometimes erroneously named *Phellinus linteus* (Berk. & M.A. Curtis) Teng, which is known for its use in traditional Chinese medicine (Ying et al. 1987, Shon et al. 2003). Larsson et al. (2006) have researched the perplexing taxonomy of *Hymenochaetales*, while Tura et al. (2011) have conducted cultural-morphological investigations on

I. baumii [sub *Phellinus baumii*] and *P. linteus*. According to these authors, the taxonomic delimitation at the generic and species level in *Phellinus* s.l. and *Inonotus* s.l. is confusing, and *P. linteus* and *I. baumii* [sub *P. baumii*] show close phylogenetic relationships within the *P. linteus* species complex.

Wu et al. (2012) investigated the species delimitation of the *I. baumii–I. linteus* group (including taxa recorded as *P. linteus*) and included the "sanguangh mushroom," a popular polypore used medicinally in China, Japan, and Korea. They described the "sanguangh mushroom" as a new species (*Inonotus sanghuang* Sheng H. Wu et al.) growing solely on *Morus* sp. in China, Japan, Korea, and Taiwan. Wu et al. (2012) also reported *I. baumii* on living *Syringa* sp. distributed in temperate NE Asia. Parmasto & Parmasto (2001) highlighted the need for correctly identifying the host species when collecting *Phellinus* species on trees or bushes in tropical and subtropical areas. The effects of Cambodian *P. linteus* in the wood chemistry and structure of *Shorea obtusa* Wall. ex Blume were investigated by Srivilai et al. (2013).

The aim of this paper is to contribute to the knowledge of *Inonotus baumii* in Thailand and to report three new host plants.

Materials & methods

The studied basidiomata were collected in different periods of the year in Chiangmai (Mai Hongson Province) and the northeastern region of Thailand; the morphological characters of basidiomata kept in the personal collection of one of the authors (A. Auetragul) were also examined. The morphology of fresh and dried basidiomata was analyzed in the Laboratory of Mycology of the Department of Agricultural and Forest Sciences (University of Palermo, Italy). The basidiospore length and width, mean number of pores per mm, mean size of setae, and diameter of tramal skeletal hyphae were determined according to Parmasto & Parmasto (2001). Morphological characters were also evaluated according to the identification keys of Wu et al. (2012) and Tian et al. (2013), which consider the hymenial surface pore sizes, basidiospore length and width, basidioma type, pileus surface characters, color of the pileal surface marginal zone, and host-plants. The host-plants on which we collected the basidiomata were identified according to Graf (1992). Fungal nomenclature follows MycoBank. The dried herbarium specimens are kept in the collection of AnonBiotec Institute, Department of Biotech, The North Chiangmai University, Thailand (DBNC) and the Herbarium, Department of Agricultural and Forest Sciences, University of Palermo, Italy (SAF).

Taxonomy

Inonotus baumii (Pilát) T. Wagner & M. Fisch., Mycologia 94: 1009 (2002) PLATE 1

Basidiomata woody, perennial, sessile, semicircular, ungulate or imbricate, 7 × 15 cm, 5–6 cm thick at the base, pileal surface dark grayish brown to dark gray, densely sulcate, radially rimose and cracking; margin rounded; hymenophores golden yellow when unripe then dark brown with wide and

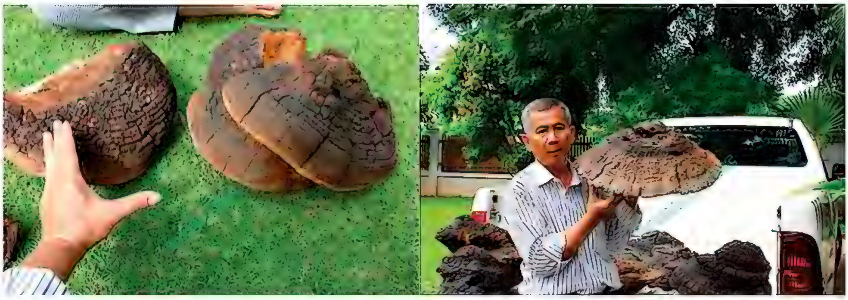

Plate 1. *Inonotus baumii* basidiomata (photos courtesy of AnonBiotec).
A, from *Shorea robusta* (DBNC 021, SAF 038); B. from *Acacia tomentosa* (DBNC 020).

sterile zone along the margin; pores regular, circular 8–10 per mm; tube layers receding in old basidiomata; context woody. Hyphal system dimitic; generative hyphae simple-septate, hyaline to golden yellow, 2–2.5 µm wide; skeletal hyphae golden yellow to golden ferrugineous, thick-walled, up to 4–5 µm wide; hymenial setae frequent to scanty, ventricose with an acute apex, thick-walled at the base, 20–27 × 5–13 µm; basidia clavate, 7–12 × 5–8 µm, tetrasporic; basidiospores broadly ellipsoid to subglobose, hyaline then pale yellowish brown, thin-walled, 6 × 5 µm.

Specimens examined: **THAILAND. Northern Thailand:** Chiang Mai Province, Chiang Mai, UTM 2077469 498244 47Q, 310 m, on living and dead trees of *Acacia tomentosa* Willd. (*Leguminosae*), 20 Oct 2012, A. Auetragul (DBNC 020); Mae Hong Son Province, Mae Hong Son, UTM 2134467 391785 47Q, 240 m, on living and dead trees of *Shorea robusta* C.F. Gaertn. (*Dipterocarpaceae*), 17 Oct 2013, A. Auetragul (DBNC 021, SAF 038); Lampang Province, Lampang, UTM 552842 2023449 47Q, 244 m, on living and dead trees of *Shorea siamensis* Miq. (*Dipterocarpaceae*), 25 Oct 2013, A. Auetragul (DBNC 022).

Identification key for *Inonotus* spp. in Thailand

(partly modified from Wu et al. 2012)

1. Pores of hymenial surface <5/mm .... ***I. lonicerinus***
1. Pores of hymenial surface >5/mm 2

2. On dead branch of *Lonicera* spp. Basidiospores mostly <4. 1 × 3.1 µm
I. lonicericola
2. Not on *Lonicera* spp. Basidiospores mostly >4.1 × 3.1 µm 3

3. On fallen trunks of *Populus* spp. Basidiomata resupinate or pileate. Pileus surface indistinctly or moderately sulcate with furrows <3/cm. Pileus always with a wide yellow marginal zone on the surface .... ***I. vaninii***
3. Not on *Populus* spp. Basidiomata pileate. Pileus surface densely sulcate with furrows >3/cm. Pileus usually lacking a wide yellow marginal zone on the surface in ripe basidiomata 4

4. On *Weigela coraeensis*. Basidiomata sessile to effused-reflexed. Pileus applanate, frequently becoming decurrent with more or less effused base, surface with a thin and black crust, margin usually thin and acute .... ***I. weigelae***

4. Not on *Weigela*. Basidiomata always sessile. Pileus applanate to concave or subungulate; surface without a thin crust. Pileus surface sometimes black and crustose in ripe basidiomata. Pileus margin acute or blunt 5

5. On *Morus* spp. Basidiomata perennial, sessile, pileate. Pileus applanate or applanate with an umbo to convex, adaxially flat, slightly convex or slightly concave. Pore surface golden-yellow, brownish yellow to yellowish brown. Pileus margin turning dark-red with KOH .... ***I. sanghuang***

5. On dead and living trees of *Syringa* sp., *Acacia tomentosa*, *Shorea robusta*, *S. siamensis*. Basidiomata always sessile, applanate to subungulate, adaxially more or less concave, margin acute or blunt, thin crust absent, although pileus surface may become black and crustose in ripe basidiomata, surface densely sulcate, with farrows >3/cm. Aged pileus usually lacking a wide yellow marginal zone on pileus surface. Pileus margin not turning dark-red with KOH. Pore surface yellowish brown. Pores of hymenial surface >5/mm. Basidiospores more or less sphaerical, 6 µm long and 5 µm wide .... ***I. baumii***

Inonotus baumii (*Hymenochaetaceae*) belongs to the *I. baumii–I. linteus* group distributed in temperate NE Asia. It has been recorded on living and dead trees of *Syringa* (Wu et al. 2012) in China (Dai 2010), Japan (Ito 1955), Korea (Lim et al. 2003), and Far East Russia (Parmasto & Parmasto 2001). *Phellinus linteus* has been reported to grow on *Quercus* L., *Cassia* L., *Lonicera* L., *Morus* L., *Symplocos* Jacq., and *Hemiptelea* Planch. (Ahmad 1972, Kang et al. 2002, Larsen & Cobb-Poulle 1990, Lim et al. 2003). However, Lim et al. (2003), who investigated basidiomata from China, Korea, Costa Rica and, Mexico, showed that the temperate East Asian species known as "*P. linteus*" represents *I. baumii*. Wu et al. (2012) proved that specimens collected on *Morus* species represent another taxon, *I. sanghuang*.

Discussion

The difficulties in identifying *Inonotus* and *Phellinus* spp. belonging to the *P. linteus* species complex fuel a wide debate on the taxonomic status of the collected basidiomata growing on different wild and ornamental trees. This is also due to the great interest by scientists and people towards the medicinal use of the mushrooms identified as *P. linteus* and/or *I. baumii*. The worldwide scientific movement on medicinal mushrooms and the mushroom industry (mainly in Asian countries) specifically requires an exact identification of mushroom species (Wasser 2013). According to our investigation the host range of the *P. linteus* species complex is not exhaustive. We report *Inonotus baumii* for the first time on three new host plants growing in Thailand: *Acacia tomentosa* (Plate 2), *Shorea robusta* (Plate 2), and *S. siamensis* (Plate 3).

Plate 2. (A) *Acacia tomentosa* in Chang Mai (Thailand);
(B) *Shorea robusta* in Mae Hong Son.

Plate 3. *Shorea siamensis* in Lampang (Thailand).

These plants are cultivated as ornamentals in Chiang Mai, Mae Hong Son, and also in Lampang. Depending on its host, different vernacular names are attributed to *I. baumii* in Thailand: the local name of *Acacia tomentosa* is "Kra-Tin-Piman" and *I. baumii* on this host is called "Hed Kra-Tin-Piman" (Hed = mushroom); the local name of *Shorea robusta* is "Jigg" (North Thailand) or "Keng" (North-Eastern Thailand) so *I. baumii* on this host is known as "Hed Jigg" or "Hed Keng". Given that *I. baumii* is collected by a large number of people attracted by the medicinal properties of the basidiomata, the above identification key should enable non-specialists also to identity *I. baumii.*

Acknowledgments

The authors wish to thank Prof. Georgios Zervakis (Greece) and Prof. Omon Isikhuemhen (USA) for carefully reading the manuscript and for English revision.

Literature cited

Ahmad S. 1972. Basidiomycetes of West Pakistan. Monograph Biological Society of Pakistan 6: 1–141.

Dai YC. 2010. *Hymenochaetaceae* (*Basidiomycota*) in China. Fungal Diversity 45: 131–343. http://dx.doi.org/10.1007/s13225-010-0066-9

Graf AB. 1992. Tropica. Color cyclopedia of exotic plants and trees. Roehrs Co. 1152 p.

Hawksworth DL. 1997. Orphans in "botanical" diversity. Muelleria 10: 111–123.

Ito S. 1955. Mycological flora of Japan. Vol. 2. Basidiomycetes no. 4. Yokendo Press, Tokyo. 450 p.

Kang HW, Park DS, Park YJ, Lee BM, Cho SM, Kim KT, Seo GS, Go, SJ. 2002. PCR based detection of *Phellinus linteus* using specific primers generated from universal race primer (URP) derived PCR polymorphic band. Mycobiology 30: 202–207. http://dx.doi.org/10.4489/MYCO.2002.30.4.202

Karaman M, Jovin E, Malbasa R, Matavuly M, Popović M. 2010. Medicinal and edible lignicolous fungi as natural sources of antioxidative and antibacterial agents. Phytotherapy Research 24(10): 1473–1481. http://dx.doi.org/10.1002/ptr.2969

Larsen MJ, Cobb-Poulle LA. 1990. *Phellinus* (*Hymenochaetaceae*): a survey of the world taxa. Fungiflora, Oslo. 206 p.

Larsson K-H, Parmasto E, Fischer M, Langer E, Nakasone KK, Redhead SA. 2006. *Hymenochaetales*: a molecular phylogeny for the hymenochaetoid clade. Mycologia 98(6): 926–936. http://dx.doi.org/10.3852/mycologia.98.6.926

Lim YW, Lee JS, Jung HS. 2003. Type studies on *Phellinus baumii* and *Phellinus linteus.* Mycotaxon 85: 201–210.

Parmasto E, Parmasto I. 2001. *Phellinus baumii* and related species of the *Ph. linteus* group (*Hymenochaetaceae*, *Hymenomycetes*). Folia Cryptogamica Estonica 38: 53–61.

Shon M-Y, Kim T-H, Sung N-J. 2003. Antioxidants and free radical scavenging activity of *Phellinus baumii* (*Phellinus* of *Hymenochaetaceae*) extracts. Food Chemistry 82: 593–597.

Srivilai P, Chaiseana W, Loutchanwoot P, Dornbundit P. 2013. Comparison of differences between the wood degradation by monokaryons (n) and dikaryons (2n) of white rot fungus (Cambodian *Phellinus linteus*). Journal of Biological Sciences 13: 131–138. http://dx.doi.org/10.3923/jbs.2013.131.138

Tian X-M, Yu H-Y, Zhou L-W, Decock C, Vlasák J, Dai Y-C. 2013. Phylogeny and taxonomy of the *I. linteus* complex. Fungal Diversity 58: 159–169. http://dx.doi.org/10.1007/s13225-012-0202-9

Tura D, Zmitrovich IV, Wasser SP, Spirin WA, Nevo E. 2011. Biodiversity of the *Heterobasidiomycetes* and non-gilled *Hymenomycetes* (former *Aphyllophorales*) of Israel. Gantner Verlag KG, Ruggell. 566 p.

Venturella G, Altobelli E, Bernicchia A, Di Piazza S, Donnini D, Gargano ML, Gorjòn SP, Granito VM, Lantieri A, Lunghini D, Montemartini A, Padovan F, Pavarino M, Pecoraro L, Perini C, Rana L, Ripa C, Salerni E, Savino E, Tomei PE, Vizzini A, Zambonelli A, Zotti M. 2011. Fungal biodiversity and in situ conservation in Italy. Plant Biosystems 145(4): 950–957. http://dx.doi.org/10.1080/11263504.2011.633115

Ying JZ, Mao XL, Ma QM, Zong SC, Wen HA. 1987. Illustrations of Chinese medicinal fungi. Beijing: Science Press (in Chinese).

Wasser SP. 2013. Modern view on current status, future trends, and unsolved problems in studies of medicinal mushrooms. 17–32, in: Proceedings of the 7th International Medicinal Mushroom Conference, IMMC7, Beijing, China.

Wu S-H, Dai Y-C, Hattori T, Yu T-W, Wang D-M, Parmasto E, Chang H-Y, Shih S-Y. 2012. Species clarification for the medicinally valuable "sanghuang" mushroom. Botanical Studies 53: 135–149.